REMARKS

Claims 1, 3, 4, and 6-8, are presently pending in the application. Claims 2, 5, and 9 have been canceled. Reconsideration and allowance of all claims are respectfully requested in view of the following remarks.

The Examiner has objected to the drawings, stating that Figs. 1a and 1b should be designated by the legend --Prior Art--.

The Examiner is respectfully requested to acknowledge receipt of one (1) sheet of Proposed Drawing Corrections which amends Figs. 1A and 1B to add the legend --Prior Art--.

The Examiner has objected to the title of the invention as not being descriptive. The present title has been deleted and replaced with the following new title: --SEMICONDUCTOR DEVICE HAVING PHOTO DIODE WITH SENSITIVITY TO LIGHT OF DIFFERENT WAVELENGTHS--, which should obviate the Examiner's objection.

The Examiner has rejected Claims 1-4 and 8 under 35 U.S.C. §103 as being unpatentable over the Applicants; Prior Art (Fig. 1b). The Examiner has rejected Claims 1-9 under 35 U.S.C. §103 as being unpatentable over Sakamoto et al. For the following reasons, the prior art rejections are respectfully traversed.

The Applicants respectfully submit that neither the prior art of the Background of the Invention section, nor Sakamoto et al., teaches or suggests a semiconductor device having a photo diode including a first conductivity type first semiconductor layer; a first conductivity type second semiconductor layer disposed on the first conductivity type first semiconductor layer; and a second conductivity type semiconductor layer formed at a surface layer portion of the first conductivity type second semiconductor layer; wherein the first conductivity type first semiconductor layer includes a surface impurity concentration greater than that of the first conductivity type second semiconductor layer; and wherein an

end face of a depletion layer on a side of the first conductivity type first semiconductor layer and a surface layer of the first conductivity type first semiconductor layer are within no more than a predetermined distance when inverse biases are applied to the first conductivity type second semiconductor layer and the second conductivity type semiconductor layer, such that a sensitivity of the photo diode to light of a first wavelength and a sensitivity of light of a second wavelength, which is different from said first wavelength, are made substantially the same, as recited in amended Claim 1.

Rather, the prior art of the Background of the Invention section and Sakamoto et al. are silent with respect to this feature.

However, the present invention discloses and teaches a photosensitive diode formed with a pin multi layered structure which has, for example, a first conductivity type first semiconductor layer, which is a first conductivity type semiconductor substrate 10, which is disposed at a predetermined distance of 3 μm or less from an end face of a depletion layer of a first conductivity type second semiconductor layer 11, and with a surface impurity concentration of the first conductivity type semiconductor substrate 10 being at least $1 \times 10^{17}/cm^3$, the carriers generated in the regions of the low impurity concentration other than the depletion layer are reduced, so that the frequency characteristics of the photo diode are improved, and it becomes possible to obtain a high speed. In other words, the impurity concentration in a direction of depth from a surface of the second conductivity type semiconductor layer increases abruptly at the point "d" as shown in Fig. 4, so that it is possible to suppress the efficiency of the photoelectric conversion in the region below the depletion layer and to make the light receiving sensitivity at 650 nm and 780 nm about the same.

Accordingly, Claim 1 is not obvious over either the prior art of the Background of the Invention section or Sakamoto et al., and the rejection of Claim 1 under 35 U.S.C. §03 should be withdrawn.

Further, since Claims 3, 4, and 6-8, depend from Claim 1, they are also patentably distinguishable

over either the prior art of the Background of the Invention section or Sakamoto et al. for the reasons cited above with respect to Claim 1.

If the Examiner believes that there is any issue which could be resolved by a telephone or personal interview, the Examiner is respectfully requested to contact the undersigned attorney at the telephone number listed below.

Applicant hereby petitions for any extension of time which may be required to maintain the pendency of this case, and any required fee for such an extension is to be charged to Deposit Account No. 19-3140.

Respectfully submitted,

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APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE TITLE:

The title was amended as follows: --SEMICONDUCTOR DEVICE HAVING PHOTO DIODE WITH SENSITIVITY TO LIGHT OF DIFFERENT WAVELENGTHS--.

IN THE SPECIFICATION:

Page 1, the third paragraph was amended as follows:

Light receiving elements, that is, photodiodes, are being widely used as optical sensors for converting an optical signal to an electrical signal for control use in optical sensor applications in a variety of photoelectronic conversion apparatuses and for optical pickup applications installed in CD, DVD, and other optical disk drives.

Page 3, the third full paragraph, continuing to page 4, was amended as follows:

However, a photo diode such as the above conventional PIN photo diode is normally designed to be in a structure which is optimized for light having a certain wavelength, for example, near 780 nm when used in a CD system and near 650 nm when used in a DVD system. Generally, in a photo diode of the same structure, there is a large wavelength dependence of the light receiving sensitivity, so when trying to receive a plurality of light having different wavelengths such as light of wavelengths of 780 nm and 650 nm, by an identical photo diode or by a plurality of photo diodes of the same structure present on an identical substrate, the sensitivity ends up greatly differing at the different wavelengths. Thus, for practical use, it was necessary to make the sensitivities match in a required wavelength region.

Page 18, the fourth full paragraph was amended as follows:

Also, the distance from an end face of the depletion layer V on the substrate side to a point where the p-type impurity concentration [start] starts to rise (corresponding to a distance between the end face of depletion layer on the substrate side and the substrate surface) can be set to be 3μm or less.

IN THE CLAIMS:

Claims 2, 5, and 9, were canceled.

The claims were amended as follows:

1. (Amended) A semiconductor device having a photo diode comprising:

a first conductivity type first semiconductor layer; [and]

a first conductivity type second semiconductor layer disposed on said first conductivity type first semiconductor layer; and

a second conductivity type semiconductor layer formed at a surface layer portion of said first conductivity type second semiconductor layer[,];

wherein[: the] said first conductivity type first semiconductor layer comprises a surface impurity concentration greater than that of said first conductivity type second semiconductor layer; and

wherein an end face of a depletion layer on a side of said first conductivity type first semiconductor layer and a surface layer of said first conductivity type first semiconductor layer are within no more than a predetermined distance [sensitivity of said photo diode to light of a first wavelength and the sensitivity to light of a second wavelength, which is different from said first wavelength, are made to become substantially the same by designing a region in which a depletion layer spreads from a junction surface of said first conductivity type semiconductor layer and said second conductivity type semiconductor layer] when inverse biases are applied to said first conductivity type second semiconductor layer and said second conductivity type semiconductor layer, such that a sensitivity of said photo diode to light of a first wavelength and a sensitivity of light of a second wavelength, which is different from said first wavelength, are made substantially the same.

3. (Amended) A semiconductor device as set forth in claim 1, wherein said depletion layer is designed to spread in a region including a region 3 to 6 μm in [the] a depth direction from a surface of said second conductivity type semiconductor layer.

4. (Amended) A semiconductor device as set forth in claim 1, wherein said depletion layer is designed to spread in a region including a region 2 to 7 μm in [the] a depth direction from a surface of said second conductivity type semiconductor layer.

6. (Amended) A semiconductor device as set forth in claim [5] 1, wherein said first conductivity type first semiconductor layer is a first conductivity type substrate, and said [a] surface impurity concentration of the first conductivity type [impurity of said first conductivity type semiconductor] substrate is at least $1x10^{17}/cm^3$.

7. (Amended) A semiconductor device as set forth in claim [5] 1, wherein [a] said predetermined distance [between an end face of said depletion layer at the first conductivity type semiconductor substrate side and the surface of said first conductivity type semiconductor substrate] is 3 μm [or less].

8. (Amended) A semiconductor device as set forth in claim 1, wherein[:] said first wavelength is 780 nm and said second wavelength is 650 nm.

IN THE ABSTRACT OF THE DISCLOSURE:

The Abstract of the Disclosure was amended as follows:

A semiconductor device having a photo diode which has substantially the same sensitivity to a plurality of light having different wavelengths, [comprising] includes a first and a second conductivity

type semiconductor layer [and a second conductivity type semiconductor layer] formed at a surface layer portion of [said] the first conductivity type semiconductor layer, wherein the sensitivity to light of a first wavelength and [the sensitivity to light of] a second wavelength which is different from [said] the first wavelength, are made substantially the same by designing a region in which a depletion layer spreads from a junction of [said] the first and second conductivity type semiconductor [layer] layers and [said second conductivity type semiconductor layer] when an inverse bias is applied to [said] the first and second conductivity type semiconductor layers [layer and said second conductivity type semiconductor layer], for example, by designing it to spread in a region of 3 to 6 μm or a region of 2 to 7 μm from the surface of the second conductivity type semiconductor layer in the depth direction.